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BEANS, PEAS, AND OTHER LEGUMES AS FOOD.

[Revised November 30, 1904.]

BY

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PREPARED UNDER THE SUPERVISION OF THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., November 30, 1904.

SIR: I have the honor to transmit herewith an article on beans, peas, and other legumes as food, prepared by Mrs. Mary Hinman Abel, in accordance with instructions given by the Director of this Office.

A number of popular bulletins have been published by this Department in the past, summarizing the available information on different food materials which enter largely into the diet of most families. The present article is similar in scope to those published earlier. Mrs. Abel has made an extensive study of the literature of the subject, and has also embodied the results gained by practical experience and many experiments, some of which were undertaken especially in connection with the present work. The relatively small number of definite investigations on the comparative value of different leguminous vegetables, and the lack of data regarding the effects of different methods of cooking, upon digestibility and similar topics emphasizes the need of more knowledge.

In preparing this revision of the bulletin some results of investigations, which have appeared since it was first issued, have been added.

Some of the illustrations used are from original drawings, others are adapted from Vilmorin-Andrieux's "Vegetable Garden," and other well-known works.

It is believed that this article is a useful summary of available information on the subject, and its publication as a Farmers' Bulletin is therefore recommended.

Respectfully,

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

121

CONTENTS

121

ILLUSTRATIONS.

BEANS, PEAS, AND OTHER LEGUMES AS FOOD.

INTRODUCTION.

The word legume is used by botanists to denote the one-celled two-valved seed pod, containing one or more seeds, borne by plants of the botanical order Leguminosæ. The most common representatives of this family which are used as food are the various kinds of beans and peas. In common usage the term is applied to the plants themselves, which are hence called leguminous plants or legumes. The term pulse is also sometimes applied to this class of plants. The papilionaceous or butterfly-shaped flowers and the pendent pods of the pea and bean are familiar in every garden, while the ripened seeds of the pea, bean, lentil, and peanut are among the standard food stuffs offered in our markets. Taking the world over, the legumes are, next to the cereals, the most valuable and the most extensively used among vegetable foods. The seeds are eaten green, either alone or with the pod, as in the case of string or snap beans and edible podded peas, and also in the fully ripened state, as split pea, dried bean, lentil, and peanut. Most species of the pea and bean have been greatly improved by the gardeners' art.

GEOGRAPHICAL DISTRIBUTION.

Representatives of the legume family are found in all climates and countries. The pea and bean grow rapidly, three to four months being sufficient to bring most varieties to maturity, and consequently they can be grown in the short summers of far northern lands, the pea, the most hardy of them, at least as far as 67° north latitude; and, as they also stand high temperatures, they are all largely cultivated in tropical and subtropical regions. The pea is the favorite legume of middle and northern Europe, while in the Mediterranean countries the bean is grown more generally than the pea. In nearly all sections of our own country both the pea and bean are grown extensively, and are even exported. Peanuts of a superior quality are cultivated in our Southern States. So far as can be learned, the lentil is at present grown in this country only to a small extent in the southwestern portion of the United States.

THE BEAN.

This valuable legume is known to have been cultivated by the Egyptians, the Greeks, and the Romans. The Romans used the broad bean (*Vicia faba*) in voting and in certain ceremonies. Early voyagers to the Western Continent speak of beans and peas as being cultivated by the Indians in different parts of North and South America, and we know that the Algonquins had one and perhaps two varieties of pole beans. The Indian name for the bean means "to wind about." Champlain, in 1604, describes the planting of what he calls the "Brazilian bean" in the region of the Kennebec. He says it grew 5 to 6 feet high and wound around the corn. It is certain that before 1600 A. D. beans were cultivated as far north as the St. Lawrence, and they were recognized by travelers as "proper to the country." Bean flour is spoken of as in use among the Aztecs. Beans are now widely distributed, one or more varieties being grown in all temperate, tropical, and subtropical countries.

The main species of beans are briefly discussed below.

FIG. 1.—Broad or Windsor bean.

BROAD OR WINDSOR BEAN
(Vicia faba).

This is the "bean of history," or that which was earliest cultivated. This bean (fig. 1) grows erect, about 2½ feet high, has a square, reddish stem, and the leaves are made up of oval leaflets. The pods are broad, thicker at the end, and generally curved and pendent, containing thickish, bulging seeds. Several varieties are grown in Europe, both for fodder and for human food, but it does not continue as long in bearing as other beans. It is said to be more generally eaten there

by the poor than by the wealthy, but, as it has a distinct and agreeable flavor of its own, quite different from the kidney bean, it should be better known among us. It is gathered when full grown, but unripe, as it is then best flavored. The Broad Windsor is perhaps the best known of the cultivated varieties but it is less successfully grown in the United States than in Europe, the climate being apparently unsuited to its best development. It is imported to some extent in exchange for varieties grown here.

KIDNEY BEAN (Phaseolus vulgaris).

This species, with its numerous varieties, comprises all beans ordinarily used among us except the Lima bean. It is a native of a warm climate, probably of South America, and was introduced into Europe in the sixteenth century. It was not known to the ancients. It has since become very important, chiefly because varieties of it are easily produced by the gardener and the quality thus improved by cultivation. What is called the "keel" in papilionaceous flowers is somewhat reduced in the kidney bean and with the pistil is spirally coiled. Cross fertilization with different varieties is said to be easily brought about. It is naturally a climber, but dwarf varieties have been developed which we call bush beans, which are used both as string or snap beans and as dried beans. This bean grows rapidly, flowering and seeding early. It has large, rough leaves, made up of three leaflets, and the butterfly-shaped blossoms, in clusters of from two to eight, start at the axils of the leaves. The pods and seeds are variously shaped and colored. The kidney beans may be divided into two groups—tough podded and edible podded (fig. 2), there being both bush and pole varieties of each group. A great number of varieties have been developed, each locality having its own favorites, and the tendency of growers to rename standard varieties or those which have developed only unimportant differences tends to confuse the nomenclature. The many "wax" beans belong to this species. Most of the "shell" beans which are eaten before fully ripe are of the pole varieties. The prejudice against beans that grow dark

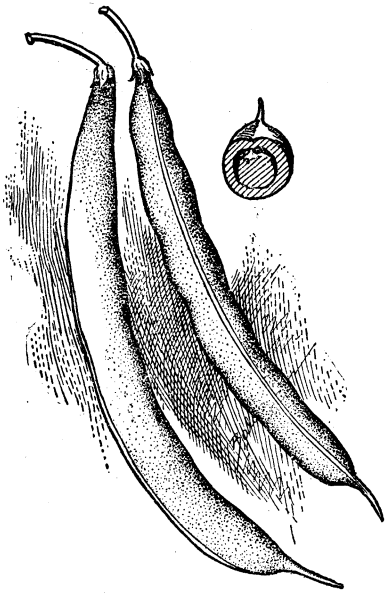

FIG. 2.—Snap or edible podded kidney bean.

in cooking is unfortunate, since many of them are of fine quality and full flavored.

LIMA BEAN (Phaseolus lunatus).

This bean is of South American origin, a tall climber, bearing a very flat, broad pod, with short, flat seeds, slightly kidney-shaped, one of the halves nearly always larger than the other and wrinkled or fluted (fig. 3). The Lima bean is of excellent quality and a favorite shell bean, both green and ripe, especially in the United States. There is also a cultural variety of bushy habit.

FIG. 3.—Lima bean.

SCARLET RUNNER (Phaseolus multiflorus).

This species, familiar as an ornamental climber but seldom used as food in the United States, is considerably used for that purpose in Europe, especially in England, some varieties being often preferred both as string and green shell beans to the kidney bean. They are, however, inferior to other beans when dry. It seems strange that this handsome climber, of vigorous and rapid growth, should be so little known as a food plant. It is used while young and tender in the form of string bean. It bears better if the growing points are pinched off.

FRIJOLE (Phaseolus spp.).

Another species which should be noted as being of local rather than general importance is the frijole (*Phaseolus* spp.) of Mexico and our Southwestern Territories, a small, flat bean frequently of a reddish brown or light tan color. Various other colors are also found. It is, next to maize, the staple food in those regions. It is largely used also as a green or snap bean. Either green or dry it is an almost daily food with the Mexicans or natives of Spanish-Indian descent.

It would seem that the dry frijole might well be used farther north. Several varieties that have been tried are very good both in soup and as a vegetable.

COWPEA (Vigna catjang).

The cowpea (fig. 4) belongs to the bean family; but it is the "field pea" of the Southern States. There are several varieties—the "red" and "black" varieties, the round "lady" peas, the large "black-eye" and "purple-eye," and the variously mottled and speckled "whippoorwill" peas, besides many others. There are both trailing and bush varieties. The plant bears a leaf with three leaflets and long pods growing in pairs on a long stem. The cowpea has been grown for at least one hundred and fifty years in our Southern States, the seed having been brought from India or China. It is grown both as a forage plant and for human food, but mainly as a fertilizer for the soil (green manure). Considerable quantities of the cowpea are consumed during the season, being gathered when the pods begin to change color and before they become dry. For winter use the dry peas are cooked like other dried beans and have a very agreeable flavor.

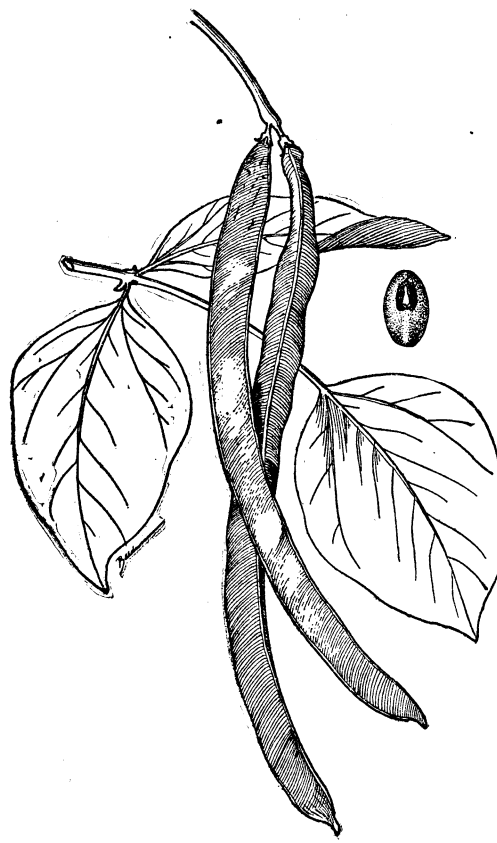

FIG. 4.—Cowpea.

The cowpea requires a longer season than the kidney bean and will seldom, if ever, mature in the climate of New England. But as a dry bean it might well be introduced into our northern markets on account of its distinctive and agreeable flavor.

SOY BEAN (Glycine hispida) **AND ITS PREPARATIONS.**

"The soy bean (fig. 5) is an erect annual plant, with branching hairy stems, trifoliate, more or less hairy leaves, rather inconspicuous pale lilac or violet colored flowers, and broad two to five seeded pods covered, like the stem, with stiff reddish hairs. The seeds vary in color from whitish and yellowish to green, brown, and black; and

in shape from spherical to elliptical and more or less compressed."[1] The plant may reach a height of 4 feet or more.

This leguminous plant, probably native in China, is the most important legume of China and Japan. Its remarkably high percentage of protein (34 per cent) and fat (17 per cent) attracted the attention of Europeans some twenty-five years ago. Since that time it has been cultivated to some extent, both in Europe and America, chiefly as a forage and soiling crop. In the Orient this bean and the various food products made from it are so largely consumed that it is perhaps the

FIG. 5.—Soy bean.

most important food plant next to rice. The soy bean is eaten to a small extent boiled like other beans, but in China and Japan it is elaborated into a variety of products, all of which have a high percentage of protein, and when eaten in connection with the staple food, rice, which is so deficient in that constituent, helps to make a well-balanced dietary. Some one of these products is eaten at perhaps every meal and by rich and poor alike, especially in the interior of these countries, where sea food is not obtainable. One of the most

[1] U. S. Dept. Agr., Farmers' Bul. 58.

important of these preparations is shoyu, and it is the only one that has been introduced to any extent into other countries, where it is known as soy sauce. To make it, a mixture of the cooked beans with roasted wheat flour and salt is fermented for some years in casks with a special ferment. The result is a thick brown liquid having a pungent and agreeable taste.

There are also several varieties of bean cheese or similar products made from this legume which are very important foods. These are natto, miso, and tofu. Natto is made from soy beans that have been boiled for several hours until very soft, small portions of the still hot mass being then wrapped securely in bundles of straw and placed in a heated, tightly closed cellar for twenty-four hours. Bacteria, probably from the air or the straw, work in the mass, producing an agreeable change in its taste. Miso is a fermented product made from soy beans rubbed to a paste with barley and salt.

For tofu, the soy bean, after soaking and crushing, is boiled in considerable water and filtered through cloth. To the resulting milky fluid 2 per cent of concentrated sea brine is added, which, probably by virtue of the calcium and magnesium salts present, precipitates the plant casein, which is then pressed into little snow-white tablets. It is made fresh every day. Tofu is sometimes cooked in peanut oil before it is eaten. In natto and miso the action of minute organisms plays an important part. In tofu there is no such action. The composition of a number of these products is as follows:

TABLE 1.—*Composition of food products made from soy beans.*

Soy-bean food products.	Water.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Fresh tofu	89.00	5.00	3.40	2.10	----------	0.50
Natto	15.32	41.42	23.65	15.05	1.48	3.08
White miso	50.70	5.70	24.40		12.60	6.60
Red miso	50.40	10.08	18.77		8.25	12.50
Swiss miso	12.53	26.43	13.91	19.54	1.41	26.18
Shoyu	63.29	8.31	----------	5.10	----------	19.45
Do	67.42	7.37	----------	4.06	----------	17.47

LABLAB BEAN (Dolichos lablab) **AND OTHER UNCOMMON VARIETIES.**

There are several kinds of beans which, though articles of diet in Oriental countries, are used only to a limited extent in the United States, usually by Chinese or other residents of foreign birth or extraction. Lablab beans (*Dolichos lablab*); asparagus bean (*Dolichos sesquipedalis*), and mungo bean (*Phaseolus mungo*), may be mentioned. The green pods of the asparagus bean (fig. 6) are largely used as a snap bean. The pods are long, containing 10 to 16 seeds, more slender than string beans, and slightly ridged along the middle of the two valves. Under the name of "tou kok" this vegetable is cultivated by the Chinese in some regions of California, and is said to

be finding favor with the white residents, being considered a valuable variety of snap bean.

LOCUST BEAN (Ceratonia siliqua).

There is still another bean which may be said to be among our local food products since the pod is regularly found in a dried state on the confectioner's stands and sold under the name of St. John's bread. It is the carob or locust bean (*Ceratonia siliqua*), grown on the shores of the Mediterranean Sea as food for cattle. It is also eaten to a considerable extent by the poorer people. The ripe seeds are surrounded by a sweet mucilaginous pulp of agreeable flavor. When dried the

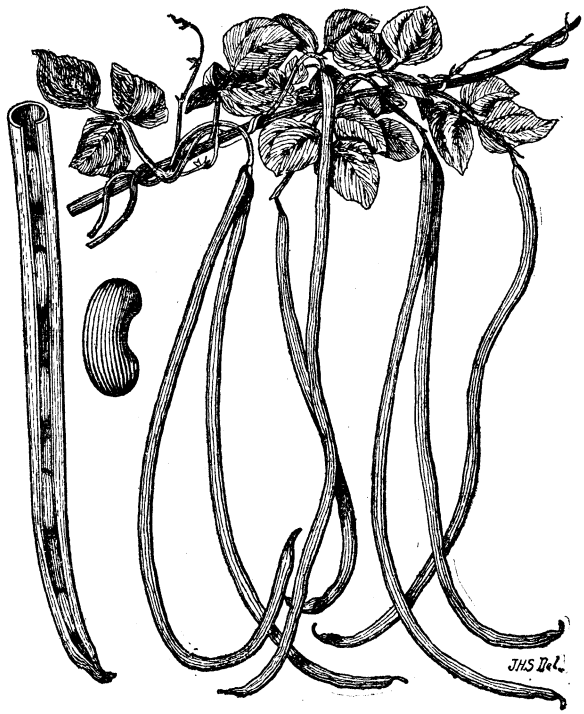

FIG. 6.—Asparagus bean.

sugar content is as high as 50 per cent. Similarly, portions of the pods of the so-called honey locust (*Gleditschia triacanthos*) are also eaten to a limited extent in this country.

THE PEA.

The pea was originally from a more northern clime than was the bean, and it has probably been cultivated from very early times, although it does not seem to have been known to the Greeks and Romans. It appeared in Europe in the Middle Ages, but it was not cultivated in England even in the time of Elizabeth. Fuller says

that peas were brought from Holland and were accounted "fit dainties for ladies, they came so far and cost so dear." From the market gardener's point of view, the pea is the most important of the legumes. In this country and in Europe great quantities are consumed in the green or unripe state, and in Europe the dried or "split" pea is as largely used as the dry bean; with us it is less popular.

FIELD PEA (Pisum arvense).

The field pea has few varieties. It has in general colored blossoms and the seeds are more or less spotted with brown. The field pea is chiefly used for fodder; but one variety, the Canadian field pea, is considerably used as a table vegetable. When two-thirds grown it is said to be delicate and well flavored, and it has the advantage of a longer season than the garden pea. As a dry pea it is inferior, as it does not cook soft.

GARDEN PEA (Pisum sativum).

The garden pea (fig. 7) has many varieties, but they are kept only by great care, as they easily revert to the original type. The cultivated pea has slender, hollow stems bearing compound leaves and terminating in tendrils which attach to any near object. The flowers, generally white, are produced in the axils of the leaves and are followed by pods containing a number of green seeds which are light green when unripe and green or white when ripe.

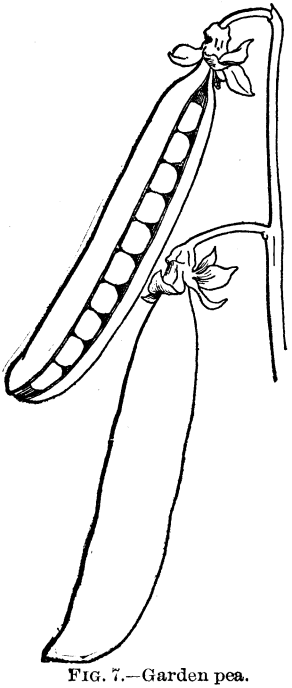

FIG. 7.—Garden pea.

The garden pea is divided into tough podded or shelling peas, the only kind in general use in this country, and the edible podded or sugar peas. Both kinds may be tall, dwarf, and half dwarf.

Shelling peas are again divided into the smooth or round seeded and the wrinkled kinds. Many varieties of both have been developed by the gardener. There is indeed a useless multiplication of names and varieties.

The edible-podded peas (fig. 8) deserve to be better known among us. Many varieties are successfully cultivated in Europe, but here as yet they are grown chiefly by amateurs and are hardly in the market. The seed is furnished, however, by most growers. This pea has a very tender pod, the ordinary parchment-like lining being much

attenuated. The pod is thicker and more fleshy than the pod of the shelling pea. It is gathered when the pea is just forming and used, pod and all, exactly like string beans. Some varieties tested were found to be excellent in flavor and texture.

CHICK-PEA OR GRAM (Cicer arietinum).

A shelling pea, practically unknown here, is the chick-pea (*Cicer arietinum*, the garbanzos of Spanish cookery, or the gram of India. It is largely cultivated in southern Europe, in Spanish America, and many parts of the East, especially British India, whence it is exported. It is a stiff, upright plant, covered with hairs and bearing inflated pods containing a few curiously shaped seeds; the two lobes distinctly marked and the germinal point very prominent.

FIG. 8.—Edible podded or sugar pea.

These peas are eaten boiled, but more commonly roasted. This roasted pea seems to have been much in use in Roman times, the phrase *fricti ciceris emptor*, "buyer of roasted chick-peas," meaning in conversation a poor fellow.

THE LENTIL (Lens esculenta).

The lentil (fig. 9) is a small branching plant with delicate pea-like leaves. The small white flowers growing in pairs are followed by flat pods, each containing two very flat round seeds, convex on both sides. Unlike the pea and bean, the lentil is eaten only when fully ripe. The brown or reddish lentil is smaller than the yellow, but of more delicate flavor.

The lentil is one of the most ancient of food plants, probably one of the first to be brought under cultivation by man. It has been

grown from early times in Asia and in the Mediterranean countries. The reddish Egyptian lentil probably furnished the "red pottage" of Esau. In Europe this legume is far less grown than the pea and bean, partly because its yield of seed and straw is less; therefore the market is partially supplied from Egypt. The lentil, according to analysis, is one of the most nutritious of all the legumes, but its flavor is pronounced and to some persons not as agreeable as that of the pea and bean. It has sometimes been claimed that indigestion and other bad effects followed the eating of lentils, but this impression is known in some cases to be traceable to the use of certain poisonous vetches, whose seed much resembles the lentil. There is every reason to consider the lentil a wholesome food. Until recent years the lentil was little known in the United States, but with the growth of the foreign population its use has steadily increased. The lentils found in our markets are all imported, but the culture of this legume with European seeds is being tried in the southwestern United States and elsewhere. There is already grown in New Mexico and Arizona, as well as in Mexico, a small variety of lentil, the seed of which was doubtless brought from Spain centuries ago by the ancestors of the present mixed race living there. The sandy soil of moderate fertility seems adapted to it; it has become acclimated, is hardy and prolific.

FIG. 9.—Lentil.

THE PEANUT (Arachis hypogæa).

The peanut (fig. 10) is so different in appearance from the bean and pea and is put to such different uses that it is seldom thought of as a legume, but a study of the growing plant immediately shows the

10020—No. 121—04 M——2

resemblance. Here we see the same struggling, more or less trailing, annual, with characteristic leaves, and the butterfly-shaped blossom, whose ovary develops into a seed pod. The manner of growth from this point is very peculiar; as the flower withers the stalk or spike of

FIG. 10.—Peanut.

the ovary rapidly lengthens and pushes into the ground, so that the pod is matured beneath the surface, but if the spike is prevented from doing this it soon withers. Other names for this plant are the earth-nut, ground nut, ground pea, goober, and pindar. Where the peanut originally grew is uncertain. It is now widely distributed in tropical and subtropical countries, Africa and our own Southern States producing most of the crop.

NUTRITIVE VALUE OF THE LEGUMES.

The different kinds of legumes are so similar in their general character, nutritive constituents, and digestibility that in these respects they may be treated together. Even in an immature state, as green peas and beans, they are, as regards composition, equal or superior in nutritive value to other green vegetables, and the ripened seed shows by analysis a very remarkable contrast to most of the matured vegetable foods, as the potato and other tubers, and even to the best cereals, as wheat. This superiority lies in the large amount of nitrogen in the form of protein that they contain.

A comparison of some of the more common fresh and dried legumes with other food materials is shown in the following table:

TABLE 2.—*Composition of fresh and dried legumes compared with that of other foods.*

Material.	Water.	Protein.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
Fresh legumes:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
String beans	89.2	2.3	0.3	7.4	0.8	195
Whole pods of *Dolichos sesquipedalis*	79.9	4.5	.5	13.9	1.2	365
Sugar peas or string peas	81.8	3.4	.4	13.7	.7	335
Shelled kidney beans	58.9	9.4	.6	29.1	2.0	740
Shelled Lima beans	68.5	7.1	.7	22.0	1.7	570
Shelled peas	74.6	7.0	.5	16.9	1.0	465
Shelled cowpeas	65.9	9.4	.6	22.7	1.4	626
Canned string beans	93.7	1.1	.1	3.8	1.3	95
Canned Lima beans	79.5	4.0	.3	14.6	1.6	360
Canned kidney beans	72.7	7.0	.2	18.5	1.6	480
Canned peas	85.3	3.6	.2	9.8	1.1	255
Canned baked beans	68.9	6.9	2.5	19.6	2.1	600
Peanut butter	2.1	29.3	46.5	17.1	5.0	2,825
Dried legumes:						
Lima beans	10.4	18.1	1.5	65.9	4.1	1,625
Navy beans	12.6	22.5	1.8	59.6	3.5	1,605
Frijoles	7.5	21.9	1.3	65.1	4.2	1,695
Lentils	8.4	25.7	1.0	59.2	5.7	1,620
Dried peas	9.5	24.6	1.0	62.0	2.9	1,655
Cowpeas	13.0	21.4	1.4	60.8	3.4	1,590
Soy beans	10.8	34.0	16.8	33.7	4.7	1,970
Chick-pea[a]	14.8	12.4	6.7	63.3	2.8	1,690
Peanuts	9.2	25.8	38.6	24.4	2.0	2,560
St. John's bread (carob bean)[a]	15.0	5.9	1.3	75.3	2.5	1,565
Potatoes	78.3	2.2	.1	18.4	1.0	385
Cabbage	91.5	1.6	.3	5.6	1.0	145
Tomatoes	94.3	.9	.4	3.9	.5	105
Rolled oats	7.7	16.7	7.3	66.2	2.1	1,850
Wheat breakfast foods	9.6	12.1	1.8	75.2	1.3	1,700
Spring-wheat flour	12.3	11.7	1.1	74.5	.4	1,650
Winter-wheat flour	11.9	10.7	1.0	75.8	.6	1,650
Lean beef	70.0	21.3	7.9	----------	1.1	730
Dried beef	54.3	30.0	6.5	.4	9.1	840
Milk	87.0	3.3	4.4	5.0	.7	325
Cheese	34.2	25.9	33.7	2.4	3.8	1,950
Butter	11.0	1.0	85.0	----------	3.0	3,605
Eggs	73.7	14.8	10.5	----------	1.0	720

[a] European analysis.

Fresh string beans, sugar peas, and shelled peas, like other fresh, succulent vegetables, contain considerable water, which, with the materials dissolved in it, forms the plant juice. They somewhat resemble cabbage in percentage composition. Fresh shelled beans, peas, and cowpeas contain a fairly large amount of protein or nitrogenous material, the nutrient which serves to build and repair body tissue as well as to furnish energy. They also contain considerable carbohydrates and small amounts of fat, both these classes of nutrients serving to supply the body with energy. The amount of ash or mineral matter in the lugumes varies in amount. It doubtless serves the same purpose in the body as mineral matter found in other food materials. The canned legumes, which are simply cooked foods sterilized and kept in such a way that they can not ferment, resemble in composition the same materials uncooked. The dried legumes contain some water, though to the eye they seem to be perfectly dry. They contain a

high percentage of protein, in this respect surpassing the other seeds commonly used as food, such as wheat. They approach animal foods as regards protein and total nutritive value, most of the legumes containing carbohydrates in place of the fat found in animal foods, though the proportion of fat may be high, as shown by the soy bean, with 17 per cent, and the peanut, with about 40 per cent, or even more. However, the relative proportion of fat and carbohydrates in food may vary within rather wide limits, since these food constituents serve the same purpose in the body, although the fats yield two and one-fourth times as much energy per pound as carbohydrates.

The fat [a] of beans when extracted is a light yellow oil resembling olive oil in appearance, which solidifies readily at a low temperature and becomes liquid again on warming. The fat of other beans would doubtless be more or less similar in its properties. Soy-bean oil is extracted and finds important uses in China and Japan. Peanut oil is extracted in large quantities and is an important commercial product. It is spoken of on page 35.

The carbohydrate group in beans, and doubtless in other legumes also, is in general made up of starch, sugar, and crude fiber. It is worthy of note that soy beans when well ripened contain little if any starch and on this account they have been recommended for the use of diabetics. The ash of legumes contains similar mineral constituents to those of other plants. It has been found that both iron and potassium are specially abundant in bean ash, one authority stating that about 80 per cent of the ash of beans is potassium phosphate. The proportion of ash is in general relatively large.

NITROGENOUS CONSTITUENTS.

Vegetable foods are nearly all rich in starch and other carbohydrates, which supply an abundance of carbon to the system; but they contain, in general, comparatively little nitrogen, an element that is of first importance in a dietary. Therefore, the very large percentage of this constituent found in the legumes constitutes for us their special interest, and the true nature of the compounds in which this nitrogen exists is also of the utmost importance.

Most of the nitrogen found in the pea, bean, and lentil is in a form very useful as food. It was called by Liebig "plant casein," on account of its general resemblance to the casein of milk. Although its action as a food is similar to the nitrogenous matter of other vegetables, it is markedly different in some of its characteristics from, for instance, the gluten of grains. Pea and bean flour will not form a dough with water and can not be used alone for making porous bread.

[a] Bean oil is made up of the triglycerids of fatty acids, and contains considerable quantities of lecithin and sulphur.

DIGESTIBILITY OF THE BEAN, PEA, AND LENTIL.

Judged by the chemical analysis alone, we should give legumes the very highest place among foods, containing, as they do, more protein than the best cuts of meat, and in some cases a large percentage of fat, besides a considerable amount of starch. Pound for pound, they would thus be more valuable than meat or our best cereals. Forty years ago they were announced by Moleschott as "true treasure houses for the renewing of our blood," being equal in their albumen content "peas to veal, beans to flesh of doves, while lentils left every kind of meat far behind."

Experiments on men and animals soon made it evident, however, that the true value of a food does not depend alone on the contained nutrients, but also on the ease and completeness with which the system utilizes these nutrients, since, to use the old adage, "Man lives not by what he eats, but by what he digests." Voit pointed out as early as 1869 that vegetable foods in general were less completely digested than animal foods, for three reasons:

(1) As generally prepared and used, the nutrients of vegetable foods are inclosed in cells composed of cellulose or woody fiber, which is more or less hard and greatly interferes with their absorption.

(2) Vegetable food is prone to fermentation in the intestines, thus increasing the peristaltic movements and, if large amounts are eaten, hastening the food onward before there has been sufficient time for the absoption of its contained nutrients.

(3) The cellulose present acts as a local irritant and produces the same effect.

PRACTICAL EXPERIENCE.

Practical experience, reaching to ancient times, testifies that beans, peas, and lentils are "hearty food." To quote the physician Galen, "they are harder to digest than other foods and give bad dreams." There is a general opinion that while they are suitable for robust people leading an active, outdoor life, indispensable to the soldier's outfit and to the logging camp, welcomed by the hunter and woodsman, and a necessary part of the food of the hard-working poor, they are, on the other hand, unsuitable for people leading a sedentary life, and are generally to be avoided by the invalid and convalescent. Such persons often complain of distress after eating beans, especially if the skins have not been removed, and of a disagreeable evolution of gas in the intestines, testifying, as it does, to the fermentability of this class of vegetables. These foods are, therefore, called "indigestible," by which is meant in common speech that they give distress or that we are unpleasantly conscious of the digestive process. These symptoms, however, do not in general indicate anything as to the

extent to which the contained nutrients of a food are absorbed or used in the system. When eaten in reasonable amount by persons in health, it is doubtful if they give rise to unpleasant symptoms. That no bad results attend their use is shown by the important place they have held in the diet since early times.

LABORATORY EXPERIMENTS.

Hoffman fed a man bread, lentils, and potatoes sufficient for his full nourishment and found that 47 per cent of the contained protein left the system unused. Of meat containing the same amount of protein, only 17.7 per cent was unabsorbed by the same person.

Woroschiloff, in comparing the digestibility of lentils with meat, found that from two to three times as much of the protein of the meat was utilized in the system as of the legume.

A very careful study was made by Strümpell of the extent of the digestibility of legumes. According to the results it would seem to depend largely on the form in which they are eaten. When he ate 250 grams (about three-fifths of a pound) of beans cooked as they ordinarily are, whole and without removing the skins, 40 per cent of the contained protein was unabsorbed or four times as much as in the case of meat. On the other hand, when he used "Leguminosenmehl," a prepared food consisting chiefly of lentil flour, only 8.2 per cent of the contained protein was unabsorbed. This equals the average digestibility of meat. As pointed out by other workers, this is, however, not a fair showing, since in order to eat enough of this lentil flour to even partially meet the conditions of the experiment he was obliged to make it up into cakes with milk, eggs, and butter, and the extent to which the nutrients of the legume were absorbed was, doubtless, much increased by the presence of stimulating animal foods.

Rubner, one of the later observers in this field, found a man who was able to eat for a few days enough cooked dried split peas (about 1.1 pounds) to fully nourish him without help from other kinds of food, peas being selected because he liked them better than beans or lentils. Even with this large quantity only 17 per cent of the contained protein was unabsorbed. It may be said that this robust individual does not represent the normal feeder, but the aim in this case is to show a comparison between this and other foods. The same man failed to use in the system 11 per cent of the contained protein of macaroni.

In some experiments recently reported by Richter the digestibility of peas was studied. The peas were cooked until soft and then passed through a sieve, some 600 grams of the purée being eaten per day. When cooked in distilled water the coefficients of digestibility were: Dry matter 92.9, protein 89.8, fat 87.6, and ash 81.1 per cent.

When cooked in hard water the coefficients were: Dry matter 91.1, protein 83.4, fat 58.9, and ash 51.8 per cent. As will be seen, the peas cooked in distilled water were the more thoroughly digested. It was also noted that the peas cooked in distilled water caused less digestive disturbance than those cooked in hard water.

In digestion experiments made at the Minnesota Experiment Station by Snyder baked beans formed a considerable part of the diet of healthy men engaged in fairly severe muscular work. The beans had been soaked in soda and water to remove the skins and were baked in the usual way, butter being added. The raw beans used had practically the composition indicated by the average figures in the table on page 17. The cooked beans naturally contained much more water (some 70 per cent) and fat (from 3 to 10 per cent) than the raw beans. When eaten with bread and milk it was found that on an average 91 per cent of the dry matter, 80 per cent of the protein, 80 per cent of the fat, and 96 per cent of the carbohydrates of the baked beans were digested. When eaten with a diet furnishing considerably more fat somewhat higher values were obtained. It was noted that the carbohydrates were more digestible than any of the other nutrients. The protein was more variable than the other constituents in digestibility, ranging in different tests from 72 to 87 per cent.

Considering the experiments as a whole, it is evident that the beans were quite thoroughly digested. It is undoubtedly true that different individuals vary in regard to their ability to digest beans, but it seems fair to conclude that when properly combined with other foods they should not be considered indigestible. As pointed out by Snyder, beans are slow of digestion and require more intestinal work than many foods, but when properly combined with other materials, so that they form a fair part of the ration, the work of digestion is more evenly distributed than when they are used alone or in very large amounts. In using beans in the dietary they are frequently eaten in excessive quantities at irregular intervals rather than in reasonable amounts combined with other foods as a regular part of the ration. It seems fair to conclude that when used in the diet in a reasonable way no difficulty is experienced in digesting beans.

FLATULENCE.

It is a matter of common experience that after eating legumes in any quantity there occurs what is known as flatulence or the formation of gas, largely methan, in the intestines. This is not confined to people of delicate digestion, although it is to them more distressing, nor does it seem to have anything to do with the extent to which the nutrients of the food are used in the system. Experiments with ani-

mals indicate that the formation of methan is entirely due to bacterial action on carbohydrates in the intestines. Rubner's man who digested so well the large amount of peas above cited complained very much of this disagreeable accompaniment. In India the mungo bean is highly esteemed and is eaten by the rich and by sick people, but always " with a seasoning of asafetida to prevent flatulence."

When beans are soaked in soda and water and parboiled to remove the skins some of the germ is also removed. The opinion has been advanced that the skins and germs are the parts of the bean which are the most fermentable and produce gaseous products during digestion. Snyder, who has made a number of studies with beans, considers that treatment with a small amount of soda and salt in cooking is an advantage since it hinders the formation of gas.

DIGESTIBILITY IN MODERATE QUANTITIES.

The digestibility of legumes is thought to be largely a question of preparation and amount eaten, as indicated above. Properly prepared and eaten in moderate quantities, peas, beans, and lentils can not be called indigestible in the ordinary sense of the word. The entire removal of the skin by sieving is to be recommended in the case of persons with whom they seem to disagree.

As to the extent of the digestibility of the contained nutrients when eaten with the above restrictions, they are probably as well used as those of other vegetable foods, but less so than the nutrients of meat. It should be remembered that a due amount of nonabsorbable or refuse matter is necessary in the food to insure the healthy action of the intestine, and it would be a great mistake to substitute, as a general thing, highly condensed foods for those containing some cellulose. None but the most hardy people could use the legumes as their sole source of nitrogenous food, since for that purpose 18 ounces daily of dried peas or beans would be necessary for a laboring man, an amount which could be furnished in not less than 6 pints of thick soup; but this fact has nothing to do with their use in moderate amounts, and there is almost no dietary in which they may not profitably find a place.

In Snyder's experiments at the Minnesota Experiment Station over a pound of baked beans was consumed per day by men engaged part of the time in active outdoor work. It is his opinion, however, that ordinarily not more than 6 ounces of baked beans, equivalent to 4 ounces of uncooked beans, should be consumed in the daily ration. While beans are a valuable food, there are, as pointed out by Snyder, certain limits to their advantageous use in the dietary. The nutrients in beans are different in character from the same classes occurring in cereals and other vegetable foods and are apparently not as readily

digested as those of many of the cereals, hence, beans are more suitable for persons engaged in active outdoor work than for those of sedentary habits. However, when properly cooked they need not be excluded from the dietary of those engaged in light muscular exercise, though they should not form as large a part of the ration as in the case of active workingmen leading outdoor lives.

It is well known that baked beans are a very important article of diet in lumber camps. Some recently published studies by Woods and Mansfield, carried on with lumbermen in the Maine woods, are of interest in this connection. The diet was made up of a few staple foods, such as bread, salt pork, beans, corned beef, salt fish, some vegetables, a few simple cakes and other pastry, molasses, and tea. Considering the average of six digestion experiments, it was found that baked beans furnished about one-third of the total protein and about one-eighth of the total energy of the diet. Although so large a proportion of the nutrients came from beans, the diet seemed to be well assimilated, on an average 85 per cent of the protein, 97 per cent of the fat, 98 per cent of the carbohydrates, and 88 per cent of the ash being digested, and 93 per cent of the fuel value of the diet being available.

DIGESTIBILITY OF PEANUTS.

The peanut is remarkable among the legumes for its large proportion of fat (39 per cent) and its resemblance in taste and use to the true nuts, and, indeed, it is popularly classed with the nuts. At present there is a good deal of interest in nuts as food, and perhaps on this account peanuts in the form of peanut butter (see p. 35) and in other forms are used to a greater or less extent as articles of diet by many families. That it is perfectly possible to provide a diet in which the bulk of the protein is furnished by peanuts or other nuts is shown by the results of some recently published experiments carried on by Jaffa at the University of California. The men studied lived in health on rations composed largely of nuts and fruits, peanuts being used in several cases. It should be borne in mind, however, that experience does not indicate that a diet restricted to such foods possesses the marked advantages which some of its advocates have claimed. It is worth noting that in the southern United States and other regions where peanuts have been long cultivated they have not come to be staple articles of diet but have remained food accessories for occasional use.

Few experiments have been made to show how thoroughly peanuts are digested. In connection with his investigations, Jaffa studied the digestibility of a ration made up of peanuts and Japanese persimmons with small amounts of a cereal breakfast food, olive oil,

tomatoes, and milk. In round numbers, 87 per cent of the protein, 89 per cent of the fat, and 90 per cent of the carbohydrates eaten were digested, and 85 per cent of the energy of the ration made available. When the daily fare consisted of peanuts, apples, and dates with small amounts of other food as before, the coefficients of digestibility were much the same. These figures would indicate that the peanuts were quite thoroughly digested.

There are many persons who find that roasted peanuts eaten in any quantity are indigestible in the sense of bringing on pain or distress. This is probably on account of their rich concentrated character, though sometimes this distress seems to be due to eating peanuts which are roasted until they are very brown. It seems to be a fact that when peanuts are eaten in connection with other food, as bread, the ill effects are less marked. Furthermore, they should always be thoroughly masticated.

EXTENT TO WHICH LEGUMES ARE USED IN DIETARIES.

Since, as we have seen, peas, beans, and lentils contain as much protein as meat, and no other vegetable foods can approach them in this regard, we need not be surprised to learn that they are extensively used among all people who, either from necessity or from choice, eat little or no meat. This is but one of many instances of a wise choice of food made long before exact knowledge was able to give the reason for it.

Some food rich in protein will be found in the daily diet of all peoples. The Mongol eats with his rice, which is largely starch, small quantities of fish, fish eggs, and goose livers, but for his supply of proteid material he relies on his different preparations of bean cheese and on soja sauce made from the soy bean. The Mexican, whose supply of meat is scanty and of a poor quality, uses the native bean or frijole at almost every meal, made into a stew with vegetables and perhaps shreds of sun-dried beef, well spiced with the chili or red pepper. The cooking is said to be done now in the unsightly American tin can (in this case a lard or kerosene can), which has almost supplanted of late years the primitive earthen pot described by travelers. The bean stew or porridge, with the tortilla or cake of pounded corn, makes up the bulk of his food. The puchero or daily stew eaten by the poorer class of Spaniards has lentils for its basis, and with the Bedouins and other Asiatic people the porridge of lentils is in constant use. Church mentions twenty species of legumes, some having many varieties, that are raised in India, and there they form not an occasional but a staple food among a people who, both by poverty and by religious scruples, are prevented from eating meat. There is a Hindoo proverb, "Rice is good, but lentils are my life."

The Roman proverb, "The poor man grown rich no longer delights in lentils," intimates that though indispensable to the man of slender purse their too familiar flavor was gladly exchanged for the more expensive dish when it could be afforded. The legumes have been called the "meat of the poor." Nitti, an Italian writer, tells us that the Neapolitan bricklayers, restricted by their scanty wages to cheap food, but requiring food that is rich in protein, condemn themselves to a daily diet of kidney beans, a vegetable which is at the same time the cheapest and the richest in protein. With the Hindoo the lentil is reputed to have great staying power, and it is a favorite food among those who are to undertake long journeys. Parched as we parch corn, it is much esteemed in Egypt and Syria for this purpose. Arabs feed their horses ground beans to prepare them for extraordinary exertions.

In early days in the New England States the woodcutter who went out for a day's work in the woods in winter almost always took with him "bean porridge," i. e., beans that had been cooked to the consistency of a thick mush and then frozen in bowls. In each bowl had been placed a string, which served to lift out the contents. By the help of the camp fire the frozen cooked beans were again made into porridge.

In the dietary studies made in connection with the nutrition investigations of the Office of Experiment Stations of the United States Department of Agriculture and the earlier work from which this inquiry developed, calculations were made showing the proportion of total nutrients furnished by a number of the principal classes of foods. Taking the average of some fourteen studies with professional men of varied income and living in different regions, dried legumes constituted 0.6 per cent of the total food and furnished 2.1 per cent of the total protein of the diet—a small amount when their high food value is considered. Wheat flour furnished 8.4 per cent of the total food and eggs 2.2 per cent, or 17.1 and 4.9 per cent, respectively, of the total protein. Considering the average results of fourteen dietary studies with mechanics' families and ten farmers' families, dried legumes furnished 1 per cent of the total food material and 3 to 4 per cent of the total protein, the proportions furnished by wheat, flour, and eggs being somewhat greater than in the case of the dietaries of professional men. In studies of the food eaten by Maine lumbermen it was found that baked beans furnished 20 to 33 per cent of the total protein and 10 to 14 per cent of the total energy of the diet. (See p. 25.) The native inhabitants of the southwestern United States and Mexico are reported to consume large amounts of frijoles and other legumes. The average of four dietary studies of Mexican laborers living in New Mexico shows that these materials furnished

9.4 per cent of the total food and 21.3 per cent of the total protein. In this case eggs furnished only 0.8 per cent of the total food and 1.6 per cent of the total protein, while wheat flour furnished 12.3 per cent and 21 per cent, respectively. In the case of professional men, mechanics, and farmers the total amount of dry legumes used was small, and in view of the high food value, palatability, and low cost of this class of foods it might have been profitably increased.

PREPARATION OF LEGUMES FOR FOOD.

Since legumes are to be counted among our cheapest and most valuable food stuffs, if their contained nutrients can be digested, their choice and preparation is a matter of importance. The legumes are used—

(1) Chiefly for the tender pod, which for this purpose must be gathered when the seed is less than half grown. Such are the string bean and sugar pea.

(2) The nearly grown but unripe seed, as the " shell " bean and pea.

(3) The fully ripened seed, as the dried bean, pea, lentil, and peanut.

(4) The flour or meal made by grinding the fully ripe seed—bean, pea, or lentil, and the " butter " ground from the peanut.

STRING BEANS AND SUGAR PEAS.

French beans (*haricots verts*), snap or string beans, are the immature fruit pods of several varieties of the kidney bean, both the dwarf and the climbing. The best have little or no " string," some requiring no preparation for cooking. They must be freshly gathered and so young that the beans are hardly noticeable when they are cooked. After the string, if present, is removed, the pods are cooked, either whole or broken into bits. The German method is to cut them transversely a few times or " whittle " them. This seems to shorten the time of cooking and to allow of better distribution of seasoning. They are then boiled in salted water and drained, or the water may be thrown away after a few moments of boiling, the beans being then stewed in as little water as possible and the seasoning added when they are half done.

When the beans form the main dish of the meal, a piece of fat meat is often cooked and eaten with them. When the bean of most varieties is more than half grown the pod is no longer tender enough to be cooked in this way. String beans that must be cooked from one to two hours are not worthy the name. When young enough and freshly gathered they will cook tender in twenty to forty minutes. There are a few varieties of which the pod is tender until nearly ripe. Sugar

peas are cooked in the same way as string beans. After the pods are full grown they become tough, but furnish a good quality of shelled peas.

Salted beans.—String beans are sometimes salted for winter use. They can be kept thus for months, and during the time a bacterium is at work effecting a change somewhat similar to that brought about by the fermentation of sauerkraut. The vegetable fiber is softened and certain flavors developed by the process. Thus preserved they are a favorite winter vegetable among the Germans. Before cooking they are soaked over night to remove the salt. Shredded string beans are also dried or desiccated and are much used by armies and expeditions.

String beans and sugar peas or edible-podded peas, eaten as they are for the pod rather than the seed, fall in much the same class with spinach, cabbage, etc. They contain relatively little nourishment in proportion to their bulk and are valuable chiefly for their agreeable flavor, the salts contained in them, and the healthful variety given to the diet.

SHELL BEANS AND GREEN PEAS.

Immature or green peas and beans freed from the pod are a highly valued article of diet in almost all countries. They contain a good proportion of proteid material and starch. The cellulose, so woody in the ripened seed, is still tender and easily cooked and the flavor is excellent. The method of preparation is very simple. They must be freshly gathered and shelled, as they deteriorate rapidly in flavor and each hour that passes after their removal from the vines increases the length of time necessary for their cooking. They should be stewed rather than boiled, the water being reduced to only enough to moisten them, and the seasoning, including a generous quantity of butter, added while the beans or peas are only half cooked. A sprig of mint added to green peas when cooking is liked by some; but it may be said in general that so delicate a flavor as that of green peas should not be covered by any strong or pungent additions. The French have a special dish, *haricots verts panaches*, or "variegated" green beans, which is a mixture of the young shelled bean with string beans.

To preserve the flavor, green beans, peas, and string beans should not be overcooked. If cooked only until tender they retain their attractive color. When overcooked they turn yellow or brownish and are much less palatable.

CANNED BEANS AND PEAS.

Beans and peas are canned in large quantities. It would seem that the process might be improved, since much of the tastelessness of canned peas is said to be due to the fact that the water in which the

peas are boiled is thrown away in the process of "blanching." Canned beans and peas are simply preserved, cooked foods having, in general, the same composition as those that come freshly cooked to the table.

DRIED PEAS, BEANS, AND LENTILS.

Green peas and beans are often to be classed among delicacies, but we have in the ripened seed a standard food for all classes. Like the grains, they have good keeping qualities and can be combined with other materials into a variety of palatable dishes. Only fat is needed to make of beans and peas a complete food in the sense that the combination furnishes the proportion of protein, fat, and carbohydrates required by the accepted dietary standards. Hence the popular combination of beans and peas with fat meat, as pork and beans, bacon and peas, and corned beef and beans.

Quality.—A well-dried bean is smooth and shining; one poorly dried may be of inferior quality, with folds in the skin. The best beans are of uniform size, not too small nor a mixture of different kinds. The larger are in general preferred because they have a smaller proportion of skin, but there are several varieties of small beans that bring a high price because they have a thin skin and fine flavor. Heavy, well-filled beans bring a higher price, the weight of a bushel of different kinds varying by several pounds. The value of the dried legume depends finally on whether it will cook soft, and this is to be determined for a given lot only by putting a sample to the test. The main requirements in the cooking of dried legumes are:

(1) To so soften and disintegrate the cellulose that the nutrients that exist in close connection with it are freed.

(2) To cook the proteid constituent so as to make it digestible and palatable.

(3) To swell and burst the starch grains.

(4) To combine with various flavoring matters, as salt, pepper, fat, herbs, and butter or fat meat so that the result shall be a palatable dish.

Different specimens of beans and peas differ with regard to the ease with which they are softened in cooking. A German investigator has attributed this difference in part, at least, to the character of the soil and other conditions of growth, and believes that it may be controlled to a certain extent by the proper use of fertilizers. However, this is a point which is not definitely understood.

Treatment of the skin.—The first step in the ordinary household practice is the swelling and softening of the legume by soaking in water a number of hours, usually not less than eight, and the removal of such parts as will not soften by cooking. Some cooks, however,

believe it is not necessary to soak the beans. They cover them with hot water and allow them to stand a short time before boiling. The first method is to be preferred.

In the ripened and dried legume the envelope becomes tough and leathery; even when cooking has done its utmost, these skins and hulls pass through the intestinal tract quite unchanged. The skin of the ripened pea and lentil is easily removed and the "split pea" and the lentil, as generally sold, have this decided advantage over the bean in the making of digestible soup and porridge. Many kinds of beans, however, after proper soaking, may be freed from their skins by stirring in water. The skins, rising to the top, are then skimmed off. The large Lima beans after soaking may easily be slipped out of the skin by pressing between the fingers. They can then be boiled and served as a vegetable of the consistency of mashed potato—sometimes called bean pudding. Peas pudding cooked in the same way is a familiar dish. In cooking beans for soup the skins may be separated by sieving.

Many housewives use soda to soften the bean skins so that they can be readily removed before baking. Snyder, at the Minnesota Experiment Station, has reported some investigations which have to do with this subject. A half teaspoonful (3 grams) of baking soda dissolved in 2 quarts of water was used to a pound of beans. When the beans were parboiled before baking some two-thirds of the water and 84 per cent of the soda were absorbed. The soda retained had probably entered into chemical combination with the proteid material of the beans. Only 0.66 per cent of the total nitrogen of the legumes was extracted by the water used for parboiling them, a loss which is unimportant. The skins removed by parboiling constituted about 6.5 per cent of the total dry matter of the beans. As shown by anaylsis, the skins contain a relatively small amount of protein and a fairly high percentage of crude fiber. As crude fiber is not readily digested by man the removal of a considerable proportion of it can not be considered a disadvantage. The digestibility of the skins which were removed, as well as that of the beans baked with and without parboiling, was tested by artificial methods, using ferment solutions. It was found that treatment with soda and water had a favorable effect upon the digestibility and food value of the beans, as it enabled the digestive ferments to act more readily upon the protein than was otherwise the case—that is to say, the beans thus treated were more quickly digested. The effect of soda on flavor is spoken of beyond (p. 32).

Hard v. soft water for boiling.—Kosutány studied the cooking of beans, especially the time required with distilled water, river water, well water, and water to which either sodium bicarbonate or magnesia

had been added. As shown by the amount of water absorbed, the beans cooked better in distilled water than in tap water or well water. Although the softening was influenced by the lime and magnesium content of the water, it was not found to be directly proportional to the lime content. The beans cooked more readily when soda was added to the water and less readily when magnesia was added. In general, fresh beans did not cook as readily as older ones.

Strümpell in the course of his experiments on the digestibility of legumes compared the use of distilled water with that to which a certain amount of lime salts had been added. Lentils cooked in distilled water took up nearly double their own weight of water and cooked soft in one and one-half hours. Some of the same kind of lentils cooked in the hard water took up only their own weight of water and after boiling for the same length of time only the skins had swollen and lay in folds over the kernel, which remained entirely hard. Such extreme results would not follow the use of ordinary hydrant water, as it is less hard than the artificially hardened water in this case, but in proportion as it contains these salts it is unsuitable for the cooking of legumes.

The water for cooking dried legumes, it is agreed by all writers on the subject, should not be "hard" water, by which we mean impregnated with various salts, as lime and magnesia salts, since the legumin of the seeds forms with these salts insoluble compounds, with the result that portions of the vegetable remain hard, no matter how long they are cooked. Rain water is preferable for cooking legumes.

The question then arises, What is to be done when the only water obtainable for cooking is hard water? In most books on cookery it is advised to add to the water in which peas and beans are cooked a small quantity of baking soda, a teaspoonful to the gallon, since, if the hardness is due to calcium carbonate, the soda will remedy it for cooking purposes. Just why it is not easy to say. Peas and beans cooked in this water are indeed easily softened, but experiment shows that the flavor may be injured. If soda is added, it is better to boil the water before using. But since the cook has generally no means of knowing the degree of hardness of the water and thus the exact proportion of soda to be added, it is perhaps better to simply boil the water before using and pour it from the sediment. When the hardness is due to the presence of the sulphate of lime or magnesia, neither boiling nor the addition of soda will avail to make the water desirable for cooking legumes. It is often possible to use rain water for cooking legumes, and this naturally distilled water is the very best for the purpose. The soft water should be used both for soaking and cooking. As noted elsewhere (see p. 22), Richter found that peas

cooked in hard water were less thoroughly digested and caused more digestive disturbance than those cooked in distilled water. The inferior assimilation was attributed in part to the formation of compounds of the fat and proteids of the peas with the alkaline earth salts of the hard water which were not broken down by cooking or by the digestive juices, and in part to the salts present in the hard water.

Flavor.—Soaking legumes in fresh water seems also to remove a certain bitter taste, especially noticeable in lentils, and in Eastern countries lentils are sometimes soaked for days for this purpose.

All dry legumes require a long application of heat, not only to soften the cellulose, but to develop the proper flavor; some say as long as twelve hours. The difference of opinion on this seems due to a differing estimate as to what is the desired result. The dried pea or bean that has been soaked over night in water may be in one and one-half to two hours cooked soft enough to be pressed through a sieve, but the tongue can still detect individual grains. To disintegrate and soften absolutely every particle and to develop the best flavor a much longer time is needed. The dish of pork and beans baked all night in the New England brick oven, the pea soup slowly cooked for twelve hours, as in some of the special ovens which cook food very slowly, are instances of legumes properly prepared. Though the amount of protein in beans is large they contain only a small amount of fat, and hence the addition of fat in the form of salt pork or butter in preparing them for the table is reasonable, since in addition to improving the flavor it makes a better balanced article of diet. The flavor of dry legumes is thought by many to be improved by the addition of onions and flavoring herbs or meat broth. Perhaps the best, as well as the most common, method of preparing the dried pea and lentil is in a thick soup or purée seasoned with salt, pepper, and butter. Beans are also often cooked in this way, although perhaps more frequently served in the United States as baked beans.

BAKED BEANS, PEAS, AND COWPEAS.

After a preliminary boiling, beans, peas, and cowpeas may be baked in an oven, with various additions thought to improve the flavor, as pork, molasses, etc. The small white or navy bean is quite generally used for this purpose, chiefly because its skin is thin and tender, but the mode is well adapted to all varieties of beans. It is generally thought that the fat present in such dishes improves their flavor.

ROASTING.

While roasting is almost the only method in use among us in the preparation of the peanut, it is perhaps never applied in the United

States to the other legumes. The pea and the lentil are roasted in the Mediterranean countries and form there a regular article of food. In India peas are parched in hot sand. For a people who possess only primitive cooking appliances, roasting certainly has the advantage over boiling. Just as a quantity of peanuts may be roasted with a handfull of charcoal, while at least two hours of stewing are needed to soften them, so the chick-pea, as found by experiment, can be parched over coals in a few moments and thus made edible. The taste reminds one of pop corn and roasted chestnuts. A slight bitterness is present, due, probably, to the skin, which does not slip off in roasting, as does the skin of peanuts. When this skin is removed before roasting, as it may be by a half hour's soaking, the product is improved.

Although these roasted legumes may not be needed as an addition to our bill of fare, it is easy to see how valuable they may be to the Arab who toils over arid plains or to the native of India in his mountain journeys.

Our common split pea is also palatable when parched. Parched peas are too hard for any but the strongest teeth, and, as used in India, they are ground and cooked after parching. The roasted chick-pea is also used as a substitute for coffee. The roasted peanut is spoken of later.

PEA AND BEAN FLOUR.

Since it has been shown by such investigations as those of Strümpell that the legumes when ground into flour and cooked in soup or baked in cakes are much more completely digested than when cooked whole, it would seem that bean, pea, and lentil flour, as such, would be common in the market. It is, however, offered only in small packages mixed with the flour of grains and sold under various trade names as a nutritious and digestible food, especially recommended for invalids. In preparations for the market it has been cooked for a long time under pressure.

In certain countries of Europe a proportion of bean flour is mixed with wheat flour for bread making, especially with wheat which has a low percentage of gluten or that in which the gluten has deteriorated in quality because of the sprouting of the grain in wet seasons. In such cases an addition of 2 to 4 per cent is thought to improve the bread, and 2 per cent, if stamped on the package, is allowed by law.

SOUP TABLETS AND PEA SAUSAGE.

Finely ground peas, beans, and lentils form the basis of many soup tablets and condensed foods used extensively by armies, explorers,

etc. The best known is the "pea sausage," which did such good service for the German troops in the Franco-Prussian war. It was invented by a cook, and the German Government bought the secret of its preparation. It consists of pea and lentil flour well cooked, evaporated, and mixed with a proportion of bacon, the proper seasonings, and some preservative. Mixed with hot water, it made a very nutritious soup for the soldier. It was found by the German army to be invaluable, if used only in emergencies, but its continuous use brought on digestive disturbances and the eater soon tired of its taste.

PEANUTS AND PEANUT PREPARATIONS.

Of the 4,000,000 bushels of peanuts raised annually in this country 3,000,000 bushels are used roasted. The remainder of the crop and the peanuts of an inferior grade go to the confectioner and appear in peanut candy and other confections. Therefore at present the peanut, as used among us, is hardly to be considered a food, but, as already said, only as a food accessory or luxury. It is quite possible, however, that this highly nutritious and cheap product of our Southern fields may come to be used in more ways than it is at present, and especially in combination with other food materials.

Peanut butter.—The roasted peanut ground into an oily meal has somewhat the consistency of butter and is now marketed under the name of peanut butter. Salt is perhaps quite generally added during the process of manufacture. Water is also sometimes added—usually before serving. Peanut butter is used like other butter to spread on bread, for the making of sandwiches, and in the preparation of a number of made dishes. Many persons like its flavor when it is fresh and of good quality, and it seems fair to say that the use of this and other sorts of nut butter is growing. As regards composition, peanut butter, which is essentially the ground roasted peanut, contains more protein and less fat than ordinary butter. Little is known regarding the digestibility of peanut butter, but the fine grinding would naturally seem to be of an advantage. Judged by Jaffa's experiments with a ration containing peanuts, it would be well digested. (See p. 25.)

Peanut oil.—At present the American peanut crop is not large enough to more than supply the roaster and the confectioner, hence the expressing of oil from the peanut has never become established here, but in Europe large quantities of the African-raised nut are used for this purpose. The shelled nuts contain from 30 to 50 per cent of oil. The oil is said to be of fairly good flavor, but inferior to olive oil. In 1899 some 80,000 tons of the nuts were used in Marseille alone for oil making. The unhusked nuts are passed between a pair

of rapidly revolving grooved rollers and the shells and red inner skins are then removed by a winnowing process with the use of air currents and oscillating sieves. The cleaned kernels are ground and then enveloped in fibrous mats and pressed to extract the oil.

According to Brannt, "the first cold pressure yields 16 to 18 per cent of very fine table oil. The residue is then broken up, moistened with water, and again cold pressed, yielding 7 to 8 per cent of more or less valuable oil, used for table purposes and burning. The residue from this is heated and then pressed, giving 7 to 8 per cent more oil, unfit for table use, but used for soap and lubricating." The finer grades of oil are sold as salad oil alone or mixed with olive oil.

Peanut cake.—When the oil has been pressed from the ground peanut, the mass remaining, called oil cake, is used for fattening cattle. Some experiments have also been made as to its food value for human beings. Containing, as it does, 47 per cent of protein and 9 per cent of fat and starch, and costing about 5 cents a pound, this food attracted the attention of German scientists. The oil cake was broken up and cooked a long time in water and eaten as a soup or porridge in a hospital. Most of those who tried it ate it with apparent relish, not once only, but again and again. No effort seems to have been made to ascertain to what extent it was digested, and the use of the cake does not seem to have passed the experimental stage.

COMPARATIVE VALUE OF LEGUMES IN RELATION TO THEIR COST.

The legumes have been spoken of as economical foods. The table on page 37 shows the nutrients and energy furnished by 10 cents' worth of the different fresh, dried, and canned legumes commonly eaten in the United States. For purposes of comparison similar values are included for some of the common animal and vegetable foods. In all cases the values are calculated on the basis of the composition of the food materials as purchased, and include the usual amounts of inedible material (pods, bones, etc.). The prices selected per pound are necessarily somewhat arbitrary. They are, however, based on actual market conditions found in dietary studies and other investigations, and are believed to represent a fair range of prices. The legumes, although staple foods, have not yet attained the importance of the cereal grains, and therefore vary more in price.

TABLE 3.—*Nutrients furnished for 10 cents in legumes and other food materials at certain prices per pound.*

Food materials as purchased.	Prices per pound.	Ten cents will pay for—				
		Total food material.	Protein.	Fat.	Carbohydrates.	Fuel value.
	Cents.	*Pounds.*	*Pounds.*	*Pound.*	*Pounds.*	*Calories.*
Kidney beans, dried	5	2.00	0.45	0.04	1.19	3,210
Frijoles, dried	4	2.50	.55	.03	1.63	4,190
Lima beans, fresh, in pod	3	3.33	.11	.01	.33	850
Do	4	2.50	.08	.01	.25	640
Lima beans, fresh, shelled	6	1.67	.05	.01	.17	425
Do	8	1.25	.04		.12	320
Lima beans, canned	6	1.67	.07	.01	.24	600
Lima beans, dried	4	2.50	.45	.04	1.65	4,065
Do	6	1.67	.30	.03	1.10	2,715
String beans, fresh, 20 cents per peck	2	5.00	.11	.02	.35	900
String beans, fresh, 30 cents per peck	3	3.33	.07	.01	.23	600
Beans, baked, canned	3	3.33	.23	.08	.65	2,000
Do	5	2.00	.14	.05	.39	1,200
Lentils, dried	10	1.00	.26	.01	.59	1,620
Do	6	1.67	.43	.02	.99	2,705
Peas, green, in pod, 20 cents per peck	2	5.00	.18	.01	.49	1,275
Peas, green, in pod, 30 cents per peck	3	3.33	.12	.01	.33	850
Peas, canned	5	2.00	.07		.20	510
Do	7	1.43	.05		.14	365
Peas, dried	3	3.33	.82	.03	2.06	5,510
Do	4	2.50	.62	.03	1.55	4,140
Do	5	2.00	.49	.02	1.24	3,310
Cowpeas, green, shelled	5	2.00	.19	.01	.45	1,240
Cowpeas, dried	2	5.00	1.07	.07	3.04	7,950
Wheat flour	2	5.00	.57	.05	3.76	8,250
Do	2.5	4.00	.46	.04	3.00	6,600
Do	3	3.33	.38	.03	2.50	5,495
Wheat bread	3	3.33	.31	.04	1.77	4,045
Do	5	2.00	.18	.03	1.06	2,430
Do	8	1.25	.12	.02	.66	1,520
Corn meal	2	5.00	.46	.10	3.77	8,275
Do	3	3.33	.31	.06	2.51	5,510
Oatmeal	3	3.33	.54	.24	2.25	6,195
Do	5	2.00	.32	.14	1.35	3,720
Rice	6	1.67	.13	.01	1.32	2,720
Do	8	1.25	.10		.99	2,040
Potatoes, 45 cents per bushel	0.75	13.33	.24	.01	1.96	4,130
Potatoes, 60 cents per bushel	1	10.00	.18	.01	1.47	3,100
Potatoes, 90 cents per bushel	1.5	6.67	.12	.01	.98	2,070
Cabbage	4	2.50	.04	.01	.12	315
Do	5	2.00	.03		.10	250
Beef, sirloin	10	1.00	.16	.18		1,040
Do	15	.66	.11	.12		685
Do	20	.50	.08	.09		520
Do	25	.40	.06	.07		415
Beef, round	8	1.25	.24	.16		1,120
Do	12	.83	.16	.11		745
Do	16	.63	.12	.08		565
Ham, smoked	10	1.00	.14	.33		1,675
Do	16	.63	.09	.21		1,055
Do	22	.46	.07	.15		770
Salt pork	12	.83	.02	.72		3,045
Codfish, fresh	6	1.67	.14			275
Do	10	1.00	.08			165
Codfish, dried, salt	6	1.67	.27	.01		525
Do	8	1.25	.20	.01		395
Eggs, 15 cents per dozen	10	1.00	.13	.09		635
Eggs, 25 cents per dozen	16.7	.60	.08	.05		380
Eggs, 35 cents per dozen	23.3	.43	.06	.04		275
Milk, 3 cents per quart	1.5	6.67	.22	.27	.33	2,170
Milk, 6 cents per quart	3	3.33	.11	.13	.17	1,080
Milk, 8 cents per quart	4	2.50	.08	.10	.13	815
Cheese, whole milk	12	.83	.22	.28	.02	1,620
Do	16	.63	.16	.21	.02	1,230

It will be seen that at the prices selected the dried legumes furnish more protein and energy than almost any food material except cereal grains, while the fresh legumes are directly comparable with our most nutritious green vegetables. Dried cowpeas at the price noted above

furnish more protein and energy per pound than any other legumes and almost twice as much protein and nearly the same amount of energy as wheat flour at 2 cents per pound. Dried kidney beans at 5 cents per pound supply about the same protein and half as much energy as wheat flour at 2.5 cents per pound. The facts brought out in the above table show the importance of legumes when considered from the standpoint of pecuniary economy and go to prove that they may profitably be used to a considerable extent as a source of protein when the diet is deficient in this constituent and the income is limited.

SUMMARY.

The green or immature pea and bean are among our most valuable green vegetables and fully deserve the place they now hold on our bill of fare. The value of the dried pea, bean, and lentil is such that one or more representatives are found in every country as a staple food, and they have been thus used from the earliest times. They are especially rich in protein, the nitrogenous constituent which forms the chief nutrient of meat, and are thus fitted to take the place of part of the meat in the dietary. Since in comparison with their value their price is low, they must be considered among vegetable foods as next in importance to bread. As compared with the cereals the legumes are (1) less completely digested if eaten in considerable quantities; (2) it is improbable that they can be made into any form of palatable bread, and (3) their flavor is less generally liked, and on that account they will seldom be made a regular daily food except by people who are forced to it by necessity.

As an occasional food, dried legumes are used in perhaps the majority of American families. Properly combined with other foods they form a palatable addition to the diet and help to give variety to the menu. In view of their low cost and high nutritive value and wholesomeness, they may profitably be used even to a greater extent than they are at present.

Care in the preparation of legumes is very important both as regards their digestibility and their flavor.

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The following is a list of the Farmers' Bulletins available for distribution, showing the number and title of each. Copies will be sent free to any address in the United States on application to a Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C. Numbers omitted have been discontinued, being superseded by later bulletins.

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